



**ATRC**  
ARIZONA  
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CENTER

**RESEARCH  
NOTES:**

**Project 542**

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## **CONGESTION MITIGATION RESOURCES AND STRATEGIES FOR ARIZONA'S STATE HIGHWAY SYSTEM**

### **Introduction**

Growing traffic congestion is one of the most significant problems for the transportation system in Arizona, and in the nation. Our propensity for single-occupant vehicles has produced not only well-documented metropolitan congestion but has become a universal problem, spreading to smaller urban and rural locations. Congestion affects the movement of people, and the flow of goods to market. It affects quality of life, energy consumption and the environment, including regional air quality. It impacts the ability to compete in the modern marketplace. As Arizona's population grows, congestion on the state's urban freeways and rural highways will only worsen.

A critical challenge for the Arizona Department of Transportation (ADOT) is to use a variety of practical, relevant congestion mitigation options in appropriate, collaborative and innovative ways to address current and future congestion problems. To meet this challenge, ADOT has undertaken the development of a comprehensive Congestion Mitigation Methodology for the implementation of a consistent and sustained approach to assess and manage the growing congestion problem on all elements of the state highway system. In order to develop a comprehensive methodology, on a request from the ADOT Core Team, the Arizona Transportation Research Center (ATRC) initiated the **Congestion Mitigation Resources and Strategies for Arizona's State Highway System** research project. The main goal of this

research was to develop a tool chest of practical strategies to help solve Arizona's urban and rural mobility and congestion problems as they arise in the long-term future.

### **Scope of Work**

The primary objective of this research effort was to identify a variety of practical planning tools and mitigation strategies that can be used to help anticipate, detect and solve congestion problems on Arizona's 6,200-mile State Highway System. A key factor in the long-term success of this statewide effort is building consensus among Arizona's transportation stakeholders on the issue of congestion including its definition and methods of measurement. At the conceptual stage of the project, the Technical Advisory Committee (TAC) recognized the need to carry out the research in phases. The project work scope was developed as a comprehensive three-phase work plan:

- Phase I of the research effort was to assess the current congestion mitigation practices in the state of Arizona. This identification phase involved a thorough baseline study of Arizona's current state, regional and local congestion mitigation practices, policies, measurements, and systems, as well as any ongoing congestion mitigation planning efforts. Two tasks were specifically designed to achieve the objectives of this phase: 1) Conduct an agency survey to review current agency practices; and

2) Review the current State Transportation Plan and related studies within the State of Arizona.

- Phase II of the research effort was focused on congestion itself. Two major objectives of this phase were to arrive at an acceptable definition of congestion on Arizona's highways and to analyze the methods of measuring congestion and its impacts. Three tasks were specifically designed to achieve the objectives of this phase: 1) Comprehensive review of literature; 2) Survey of agencies, transportation professionals and researchers on a nationwide basis; and 3) Regional conference and workshop.
- Phase III of the research effort was focused on the development of a toolbox of congestion mitigation resources and strategies most suitable for implementation in Arizona.

## Phase I

An Arizona agency survey was conducted to assess current practices for defining, measuring, and mitigating congestion within the state. The questions developed for the survey of key Arizona transportation stakeholders were based on the fundamental issues related to congestion. Fifteen local municipalities, counties, metropolitan and regional planning organizations, and key ADOT staff were surveyed as part of this effort. Highlights of some key issues and the survey responses to those issues were:

*Congestion Definition and Measurement* – The majority of the respondents related the definition of congestion to the *Highway Capacity Manual* Level of Service (LOS), with lower LOS indicating more congested conditions. There is a strong view that the LOS threshold should differ between urban and rural areas. Other measures of congestion used in the urbanized regions of the state include average delay per vehicle, visual observation of traffic queue lengths at major signalized intersections, and correlation of average daily traffic and LOS.

*Congestion Mitigation Strategies and Data Collection* – Current or planned congestion mitigation techniques include continuous use of the tools built into the Freeway Management System, use of alternative modes of transportation, traffic signal synchronization, network expansion including alternate routes. More congestion mitigation techniques are described in the Final Research Report number FHWA-AZ-02-542.

*Performance Measures for Strategies* – There was wide variation among respondents on how their agencies evaluate and select mitigation measures. Measures cited include system evaluation through modeling; using perceived customer tolerance levels; measures based on traffic volumes; observed congestion; accident experience; and existing and planned land uses.

*Congestion Management and Monitoring* – Some agencies are developing their own traffic monitoring systems in response to increasing congestion. Congestion problems are typically reviewed on a case by case basis, district by district, and community by community.

The findings of the Arizona agencies surveyed provided a good background and resource in the development of the congestion mitigation strategies toolbox. Review of the State Transportation Plan and related studies provided a useful guide and input in the selection of appropriate congestion mitigation strategies.

## Phase II

A review of current literature was performed to identify practical planning tools and mitigation strategies that can be used to help anticipate, detect and solve congestion problems on the Arizona State Highway System as they arise. The purpose of the literature review was to identify the range of current measurements, technologies, and strategies being implemented to measure, monitor and mitigate congestion in the United States. The comprehensive literature review recommends the following: 1) develop criteria for performance measurement; 2) identify techniques to collect or estimate

congestion data; 3) develop strategies to mitigate and/or manage congestion; and 4) develop evaluation procedures.

The national industry survey used the same instrument as that used in the Arizona agency survey. The respondents selected for the survey were transportation professionals in other state DOTs, regional governments, university research centers, and private transportation companies. The objective of the national industry survey was to acquire an understanding of the profession's current focus with respect to reducing traffic congestion. The interviews attempted to validate current understanding of the most applicable definitions of congestion, as well as the commonly used congestion measures. Furthermore, the interviews sought to enhance knowledge about the tools that are now available or can be useful in the near future to combat or prevent congestion. Results of the survey indicated that Arizona is in a similar situation to its partner states throughout the country in striving to manage congestion, in incorporating performance based measures, and in attempting to tie congestion monitoring to planning and programming.

The Arizona Department of Transportation held a conference and workshop in Phoenix on March 5, 2002. The primary goal of the conference and workshop was to help understand the ways in which traffic congestion is effectively defined, measured and dealt with, and to begin building consensus around the issue of congestion mitigation in Arizona. The key objective was to begin a statewide discussion on the best congestion definitions and performance measures to be incorporated into ADOT's planning and operations. The conference provided an opportunity for Arizona's transportation stakeholders to share their thoughts and experiences on congestion. The conference yielded considerable insight with emphasis on Arizona-specific issues. The information collected at the conference was added to the pool of data used to develop the desired congestion mitigation resources toolbox for ADOT.

## Phase III

The main objective of the research project was to develop a resource toolbox of congestion mitigation remedies appropriate for Arizona's State Highway System. The envisaged resource toolbox was to include a database of the recommended congestion mitigation strategies. In the course of the research study, the concept of a resource toolbox evolved to incorporate the need for a valid congestion index. The concept of a congestion index as part of the resource toolbox for ADOT was an offshoot of the search for the best definition of congestion, and appropriate congestion measures for urban and rural congestion problems.

*Congestion Index* – The review of literature sources verified that measurement of congestion is critical in assessing the current status of congestion and the level of benefit derived by implementation of mitigation strategies. "Congestion Index" is the terminology used to denote the measures of congestion. For this study, the congestion index is a "travel time index" where the measure of congestion relates to the time taken to traverse a particular stretch of road, or the time from an origin to a destination. The travel time index is defined as the ratio of peak travel times to free-flow travel times. One of the advantages of this type of measure is that numerous methods can be used to derive the index values for certain facility types. Travel times can be directly measured or collected using a variety of techniques.

*Congestion Mitigation Strategies Database* – The development of the strategies database takes into account the findings and recommendations from Phases I and II of this project. The Congestion Mitigation Strategies Database consisting of 99 strategies was developed in Microsoft Access. These strategies were developed based on the comprehensive literature review, interviews, survey responses and the congestion conference and workshop. The recommended strategies were selected on the basis of relevancy to the characteristics and needs of Arizona and its State Highway System.

## Recommendations

This research project includes the following recommendations for implementation of the ADOT Congestion Mitigation toolbox on the 6,200-mile State Highway System in Arizona:

### *Congestion Mitigation Strategies Database*

- Use of the 99 strategies identified to mitigate congestion on the state highway system;
- Utilization of the strategies database to identify strategies that will achieve specific performance objectives and benefits;
- Application of the strategies database at the planning, programming, and project levels for congestion mitigation; and
- Use of the database by other agencies in Arizona and elsewhere in developing congestion mitigation solutions.

### *Congestion Index*

- Use the travel time index as the key measure of congestion;
- Utilize existing data and information systems to estimate congestion;
- Recognize that the congestion monitoring process will evolve over the next 5 to 10 yrs.;
- Develop “mobility targets” (i.e., acceptable congestion standards) based on location, functional classification, and/or route level of development. For example, ADOT should develop “mobility targets” that define the acceptable travel time index values (analogous to defining an acceptable level of service);
- Use mobility targets to differentiate between acceptable urban and rural congestion;
- Periodically examine and update mobility targets based upon congestion benchmarks and customer satisfaction; and
- Consider a pilot project and/or phased implementation as a means to fully develop the congestion monitoring and mitigation program.

### *Implementation Approach for Congestion Monitoring in Arizona*

The recommended short-term approach for congestion monitoring on Arizona State Highways should rely on three primary sources

of ADOT data to estimate both recurring and non-recurring congestion:

- Archived Operations (or Intelligent Transportation System) Data
- Highway Condition and Reporting System
- Transportation Planning Division Traffic Database

## Conclusion

This research project has resulted in the development of practical strategies to solve Arizona’s mobility and congestion problems. A significant step in the development of the Congestion Mitigation Methodology was building a consensus among traffic management stakeholders on effective definitions for congestion and for congestion management. Input on the definitions and state of the practice in congestion mitigation came from a national survey of MPOs and state DOTs, and from a regional conference on congestion mitigation.

The research project has produced recommendations for how to systematically quantify congestion on Arizona’s highways using a state-specific congestion index, and it also has produced a database of available congestion mitigation strategies in Microsoft Access. The Arizona congestion index, mitigation strategies database, and a set of sound, practical project programming procedures are the primary elements of the emerging ADOT congestion mitigation toolset.

Note: The full report on this project, *Congestion Mitigation Resources and Strategies for Arizona’s State Highway System, Final Report 542: Vol’s I & II, 2002*, by Nayan S. Amin, Virginia A. Sapkota, & Cody T. Christensen, of Bucher, Willis & Ratliff Corp. (Arizona Department of Transportation, Report FHWA-AZ-02-542, dated October 2002) may be obtained by faxing a request to 602-712-3400, or from the ATRC Publications web link at: [www.dot.state.az.us/ABOUT/atrc/Index.htm](http://www.dot.state.az.us/ABOUT/atrc/Index.htm).